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ABSTRACT

Teacher-developed tests can be more valid and reliable than standardized tests or state-mandated tests in evaluating student achievement in science. Many teachers, however, are not acquainted with the standards to use in test writing. The National Research Council has released "Classroom Assessment and the National Education Standards," a publication that outlines six goals for classroom assessment. A science portfolio is a good way to evaluate the everyday science achievement of students. Using Multiple Intelligences Theory (H. Gardner, 1993) can show ways to assess student achievement through their individual strengths and the use of the various types of intelligence suggested by the theory. Learning styles theory also has much to offer classroom assessment. When teachers want to use written tests, there are criteria that should be applied to the construction of test items. Teacher observation is another important aspect of assessment in science. It is also important to consider metacognition skills when evaluating student achievement in science. Students must learn the skills required for self-evaluation, and teachers must help them develop these skills. (SLD)

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Teacher Involvement to Evaluate Science Achievement

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TEACHER INVOLVEMENT TO EVALUATE SCIENCE ACHIEVEMENT

Much is written about using standardized and state mandated tests to measure student growth in science. Little, however, is written about using teacher developed tests to measure student science achievement in the classroom. Too frequently, standardized tests and state mandated tests omit learner progress in the every day learnings in science achievement in the classroom. Teacher developed tests can be more valid and reliable then either standardized or state mandated tests. Standardized tests are global and do not have accompanying objectives for the teacher to use in teaching science. State mandated tests may have accompanying objectives which teachers may use to gauge their teaching. The teacher may then teach in a manner whereby the state mandated test might have rather high validity since what is taught may be tested when using the state mandated test. Selected states omit science content and skills in the mandated tests. The feeling then might well be that science is not as important as reading and mathematics, for example.

There is probably no better way to write valid test items than the classroom teacher doing the writing who knows and understands what has been taught in the classroom. The science teacher also has understandings of what the developmental level of the student is when writing appropriate test items. Thus, test items need to be written on the reading and understanding level of the students who are to take the test.

Too many teachers, however, are not acquainted with standards to use in test writing.

Standards for Test Writing

The National Research Council (NRC) has just released publication of Classroom Assessment and the National Education Standards (National Science Teachers Association, 2001). Six goals are listed in the introduction of this publication and these are the following:

* Articulate a research based rationale for helping teachers improve classroom assessment.
* Clarify the concept of effective classroom assessment.
* Provide illustrations and guides to the development and selection of assessment processes and tools.
* Assist teacher educators and staff developers who will include assessment in their work with prospective and practicing teachers.

* Address issues that school and district decisionmakers face in their efforts to improve classroom assessment.

What students learn each day in ongoing science lessons and units of study is important. A single percentile given to show student results on a standardized or state mandated test for an entire school year, or other selected interval of time, does not provide a comprehensive picture of the learner's achievement in science (Ediger, 1990, 241- 246). To use either of these tests to reveal learner progress in science has the following weaknesses:

1. multiple choice test items are generally used for student responses to indicate what has been learned. These are paper/pencil test items to measure facts, concepts, and generalizations acquired by students. Major emphasis may be placed here upon measuring factual information achieved by students since this is the easiest kind of content to measure in a multiple choice test.
2. hands on approaches in science teaching and learning might well be greatly minimized or ignored since their strengths and weaknesses cannot be machine scored. A science teacher who has stressed a hands on approach in student learning in the classroom may find the multiple choice test items tend to measure verbal intelligences such as reading largely or only.
3. no exceptions may be made for individual differences among students. Thus all students have the same amount of allotted time to complete the standardized or state mandated test, all experience the same directions for test taking, all responses are assessed using the same answer key, and all respond to the same kind of test items. Selected students need more test taking time than do others as well as to have directions explained more thoroughly for taking the test. Then too, there may be more than one correct answer than what is presented in the assessment key. Reading multiple choice test items may not be a favorite way of revealing what has been learned in science. A handicapped student, especially, may need special accommodations.
4. science as a curriculum area may not appear on a state mandated test since major emphasis is being placed upon measuring reading and mathematics achievement. Standardized tests, if they do contain test items pertaining to science, may have too few test items pertaining to this vital area of academic achievement.
5. validity may well be lacking if the test stresses abstract

learnings such as students reading and responding to multiple choice test items and the classroom teacher having emphasized concrete and semi-concrete approaches in teaching science.

A sampling of every day science achievement of students may be incorporated into a science portfolio. The portfolio, as an example, may contain the following entries:

1. snapshots of hands on approaches from ongoing lessons and units of study.
2. written work pertaining to summaries; outlines; book reports; as well as expository, creative, and narrative writings.
3. a video tape of collaborative endeavors of students to notice the quality of interactions.
4. tape recordings of oral presentations such as a book report.
5. drawings of construction items made for science experiments and demonstrations.
6. dramatizations, evaluated on a five point scale, pertaining to a unit on famous scientists, for example.
7. self evaluation of students in terms of quality criteria.
8. art products such as murals, diagrams, and other illustrations developed of what was studied in science units of study.
9. test results of classroom developed tests measuring achievement in ongoing units and lessons.
10. student/teacher planning of what is left to learn within a specific unit in science. A carefully designed rubric may be used to assess the quality of each portfolio (Ediger, 2001, 150-155).

Multiple Intelligences Theory

Multiple Intelligences Theory (Gardner, 1993) indicates that there are numerous possibilities for students to reveal in achievement. Here, students may use their own individual strengths to indicate achievement through the following ways:

1. verbal intelligences such as in reading and responding to test items.
2. logical intelligence as in reasoning to secure information.
3. musical/rhythmical such as in writing lyrics and putting the words to music to reveal what has been learned.
4. intrapersonal intelligences whereby the strengths lie within the individual working by the self to indicate achievement from a lesson or unit of study.
5. interpersonal intelligences in which a learner best reveals learnings obtained through collaborative endeavors.

6. bodily/kinesthetic whereby the student indicates what has been learned through manual dexterity. There are a plethora of ways here for students to show achievement in science units such as in constructing models and objects, making science equipment, and doing projects.

7. scientific intelligences which is truly the heart of the science curriculum as in objective thinking about nature and the natural world.

The student with teacher guidance may select the approach(s) to be used to reveal what has been learned in science lessons and units of study. This puts more responsibility upon the student, rather than upon test writers far removed from the local classroom, in deciding how to be assessed to indicate achievement. Each of the above named intelligences possessed by a student may be used to show progress in the science curriculum.

To use multiple intelligences theory requires inservice education for teachers. Classroom teachers need to study, see models of multiple intelligences theory in operation to assess learner achievement, and eventually implement with mentor assistance diverse facets of this philosophy of evaluation. In service education is necessary then for teachers to be able to use new procedures in the assessment process.

Learning Styles Theory in the Assessment Process

Under which classroom environmental conditions do students achieve more optimally? Learning styles theory has much to offer in thinking about the learning environment for students in the classroom. Searson and Dunn (2001) in their research have identified factors which assist or hinder individuals in the classroom in achieving as optimally as possible:

1. acceptable noise levels, temperature readings, as well as formal versus informal seating arrangements.

2. emotional elements such as conformity versus nonconformity, as well as preferences for choices as to what to learn.

3. sociological factors such as studying alone or with others as well as well as preferring collegial relations versus structure with a more authoritative teacher.

4. physiological factors such using auditory, tactual, nd/or kinesthetic ways of learning. Included too are moving around or sitting still as well as eating versus not eating while

concentrating on the task at hand.

5. psychological factors such as being an analytic learner who focuses on a step by step fashion which leads to an understanding, as compared to global learners who desire to understand what is learned and how it relates to themselves before focusing on facts. Analytic students respond best to printed words whereas global learners respond better to illustrations and pictures.

Workshops and faculty meetings are needed for teachers to become thoroughly familiar with learning styles theory of teaching and learning as well as using its components in the assessment procedure. Teachers need to consider learning styles theory when evaluating under which conditions students do best in achieving objectives in science instruction.

Written Tests in the Science Curriculum

There are selected criteria which need to be used by teachers in writing valid and reliable test items to measure learner achievement and progress. Quality test items then need to be in the offing for assessment results to be useful for the science teacher. Poorly written, vague items will not provide the useful information needed to design the science curriculum. Which are selected criteria for the teacher to use?

Multiple choice test items are used very frequently by writers of standardized and criterion referenced tests. Teacher written multiple choice test items should possess the following:

1. they should contain a stem and four plausible responses. Four is not a magic number, but if there are three responses, then the student has a better chance of guessing the correct answer. If five responses are in the offing, it might be quite complex in writing each as being plausible or rational.

The following is a model multiple choice item:

Which is <u>incorrect</u> in naming the three states of matter?

a) solids.
b) rocks.
c) gases.
d) liquids.

There is only one correct answer in that rocks are not one of the three states of matter. The test item is quite factual. However, there are vital facts for students to understand and use in developing increasingly a more complex science vocabulary. Thus, there are a plethora of liquids, solids, and gases for students to encounter in a quality, sequential curriculum. Then

too relevant facts are the building blocks for higher levels of cognition.

2. no clues are to be given when the student encounters sequential multiple choice test items. Thus, test item number one should not provide a clue as to which is the correct response for test item number two, and others sequentially.

3. each stem needs to be grammatically correct with the four plausible responses:

Three major classification of rocks are

a) sandstone, basalt, and marble.
b) igneous, metamorphic,and sedimentary.
c) liquids, solids, and gases.
d) conglomerate, magma, and shale.

4. the test items need to be arranged n ascending order of complexity. The reason for this being psychological in that the easier test items may build self confidence within students to tackle the increasingly more complex test items sequentially.

5. written test items must cover what has been taught in the classroom so that increased validity is in evidence.

6. peer review of test items may be advisable to take out the weaknesses in a multiple choice test.

7. balance among different topics covered in science instruction need to appear on the test. If environmental education has been taught in class for example, then related test items need to appear on the test. Face validity is then in evidence (Ediger, 1994, 1-4).

8. feedback from student test results should be used to pinpoint weaknesses and thus reteach that which is needed.

9. printouts of learner test results provide a basis for assessment of the quality of test items. If too many miss an item, perhaps it needs to be revised to make it more meaningful.

10. tests are an integral part of instruction and should be used to improve the curriculum, not to make comparisons among students. Learning opportunities should be used to encourage student progress in science (Ediger, 1994, 24-25).

Teacher Observation of Students in Science Achievement

Leadership is certainly needed from teachers and the school principal to use quality criteria to ascertain student achievement in science (Ediger, 1999, 1-5). Test results may well be worthless unless the standards used in measurement and evaluation to determine student science achievement possess face validity as well as reliability, such as test/retest, alternate

forms, and/or split half. There are a plethora of factors which need to be incorporated into the writing of quality tests including being on the present reading level of students who will be taking the test. Individual differences should be provided for including variable time limits for students individually who need more time to complete a test.

To harmonize a hands on approach in teaching/learning in science with the assessment process, the teacher may use observational techniques. The following criteria may be used in the observational process by the science teacher when students are doing hands on science:

1. how well a learner is identifying problems to solve in science.
2. how effective the student is in gathering information directly related to the problem.
3. how proficient the student is in achieving an hypothesis.
4. how well the learner does in testing and evaluating the worth of the hypothesis.
5. how capable the student is in modifying the hypothesis, if necessary.

Teacher observation may be used to determine how well a student is doing in each of the five above named categories. An additional vital item to observe is how well students are using science equipment and materials in problem solving experiences.

Metacognition in Science

Metacognition skills are important to use in the evaluation process. Metacognition deals with thinking about thinking. Early in the child's school experiences, he/she should be aided to achieve as optimally as possible (See Allen, Spring, 2001). The science teacher needs to provide a model to assist students to reflect upon what has been achieved in science in an ongoing lesson or unit of study. This provides opportunities, not only to reflect upon what hs been acquired, but also for the student to think about what is left to learn. Motivational factors arise here in that the learner feels a sense of accomplishment as well as there being more to achieve. Relating that which has been achieved with what is left to learn makes for connections of the older learnings with the new. Review within the reflection process is a powerful factor in retention of subject matter, skills, and attitudes, as well as creating a desire to continue achieving. Too frequently, individuals believe that what has been learned will

remain there for retrieval. But forgetting and problems in retrieval are forthcoming. For metacognition to become an important factor in self evaluation, the student needs to

1. be responsible for his/her own achievement in science.
2. trust the self, with teacher guidance, to develop quality criteria in and for self evaluation.
3. lean upon the self to evaluate, assess, and accomplish.
4. monitor the self to determine if science goals of instruction are being achieved.
5. rehearse, analyze, and synthesize objectives, learning opportunities, and assessment procedures with each being vital in teaching and learning.

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